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The report holds that the U.S. must begin to consider actions that will reduce the negative environmental impacts produced by the present packaging systems. Observers are, for example, beginning to see limits to the availability of raw materials needed to make some packaging materials. Second, is the rapid depletion of the energy sources required for the production of packaging. In addition to the natural-resource issue, it is important to recognize the potential reduction in pollution that would result from reusing and recycling containers. A new system is needed in which consumption is decreased, and materials are reused and recycled.

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ENVIRONMENTAL IMPACTS OF PACKAGING

Eileen L. Claussen*

In Perspective

If we look at the historical relationship of man and nature, we find that man has always been an exploiter of nature's wealth. And that the more man has exploited nature (even at the cost of altering other living systems), the more he has been able to enrich his culture and gratify his needs and desires. We are rapidly coming to the conclusion, however, that the earth's natural resources are not infinite, and that we cannot continue to alter natural systems in the same way and at the same rate as we have in the past several hundred years.

A brief glance at trends in resource utilization will clearly illustrate this point. During the period between 1950 and 1971, the United States' demand for metals tripled and consumption of energy doubled. In 1968, our energy consumption was equivalent to 11 tons of coal for every man, woman, and child. The United States' consumption of all minerals is expected to grow at an annual rate of 4 to 5 percent until the year 2000, contributing to the rapid depletion of natural resources for the entire world.

Judgments as to the seriousness of this problem show considerable variation. Some projections indicate that known reserves of lead and

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copper could easily be depleted within 50 years.[1] Fossil fuel supplies present an even more pressing problem. It is estimated, for example, that natural gas reserves will be depleted in less than 25 years.

Our industrialized world has also altered the earth's system by polluting the environment and radically changing nature's balance. Air pollution from industrial processes in the United States totalled 39.6 million tons in 1969, an increase of 3.2 percent over 1968.[2] Between 1964 and 1968, the increase in water pollutants produced annually is estimated to have been 8.1 billion pounds. Almost 90 percent of this amount resulted from increases in production; 12 percent resulting from population growth and 88 percent resulting from increased per capita consumption of goods.[3] These data indicate the seriousness of the environmental problems that confront us as a Nation.

The Packaging Example

Packaging, one of the most dynamic and fastest growing industries in the United States, is an important contributor to these problems. Shipments of containers and packaging were valued at $21.5 billion in 1971, an increase of 5 percent over 1970, and an increase of 60 percent since 1963. The consumption of paper, glass, metal, and plastic packaging rose from approximately 41.7 million tons in 1966 to 52.5 million tons in 1971, an increase of 26 percent in 5 years. Approximately 1 million workers are employed in the packaging industry; and over 300,000 manufacturing establishments and 2 million wholesale and retail establishments depend on packaging for distributing and protecting their products.

The phenomenal growth of the industry in recent years perhaps can be attributed to an enlargement of its function and purpose. First, packaging is a system for delivering a product from producer to consumer. All packaging is therefore designed to protect and preserve its contents. More recently, however, packaging has been utilized to satisfy other needs. The high cost of labor, for example, has provided an incentive for self-service merchandising which, in turn, has spurred the growth of consumer packaging. Also, packaging users have become increasingly aware of the marketing value of packaging. This has resulted in the use of more elaborate packages designed to sell a product. The desire of the packaging industry to satisfy the convenience of the consumer can also cause increased packaging as shown by the growth of the market for food products packaged in convenient individual servings. All these factors have been responsible for substantial growth of the packaging industry.

What has this meant in terms of environmental impacts? Every production system causes some environmental impacts. Resources are used, both for the product itself and to provide energy for the manufacturing process. Air and water pollutants are created, solid wastes are generated, and eventually the product is discarded. The packaging industry, for example, accounts for 50 percent of all paper production, 87 percent of all glass production, 11 percent of aluminum production, 20 percent of plastic production, and close to 9 percent of steel production. The production of packaging raw materials alone consumed 5 percent of U.S. industrial energy consumption in 1971. And glass, paper, metal and plastic production accounted for 45 million tons of solid waste in 1971,

up from 35.2 million tons in 1966. A close look at several specific container systems will serve to illustrate the extent of packaging environmental impacts.

The Glass System. In 1971 alone, 11.1 million tons of glass containers were manufactured. This represents 87 percent of all glass produced in the United States.

To produce 1 ton of glass containers, approximately 2,400 pounds of material are used, including over 1,330 pounds of sand, 433 pounds of soda ash, and 433 pounds of limestone. The energy required for producing the containers is approximately 15.2 million British thermal units (Btu's), 14.5 million of which are derived from fossil-fuel sources.[2]

The glass-container production process also generates significant quantities of pollutants--an estimated 384 pounds of mining wastes are generated and 27.8 pounds of air pollutants emitted into the atmosphere for every ton of glass containers manufactured.[3]

The Containerboard System. Containerboard is another major packaging material. In 1971, 18 million tons were produced and consumed.

To manufacture 1 ton of containerboard, 3,688 pounds of wood are needed. Additionally, the production process requires 261 pounds of lime, approximately 360 pounds of salt cake, and 76 pounds of soda ash. During production of 1 ton of containerboard, nearly 84 pounds of air pollutants and 176 pounds of solid wastes are generated and 28.1 million Btu's of energy are consumed.

The Aluminum System. Packaging is the third largest user of aluminum, accounting for 11 percent of total production. It is estimated that 660,000 tons of aluminum packaging were produced in 1971.

To produce 1 ton of aluminum, 8,776 pounds of bauxite, 1,020 pounds of petroleum coke, 966 pounds of soda ash, 327 pounds of pitch, and 238 pounds of lime are required. The energy requirements for aluminum production are higher than for any other packaging material. Approximately 197 million Btu's of energy are required, 169 million of this derived from fossil fuel sources.

The pollutants generated from aluminum production are also significant. They include 3,290 pounds of red mud, almost 2,900 pounds of carbon dioxide, 81 pounds of particulates that enter the atmosphere, and 789 pounds of solid wastes.

The Steel System. Approximately 9 percent of all steel purchased is used by the packaging industry. In 1970, 7.8 million tons were utilized in container applications.

To produce 1 ton of steel, over 1,970 pounds of iron ore, 79[illegible] pounds of coke, and 454 pounds of lime are required. A total of 29.1 million Btu's of energy, 29 million of which are derived from fossil fuels, are required in the production process.

The pollutants generated in the manufacture of 1 ton of steel include 538 pounds of solid wastes. Approximately 242 pounds of air pollutants are also produced and emitted during the manufacturing process.

The Plastics System. Plastics are a rapidly expanding portion of the packaging materials mix. Among the many plastic resins used in packaging applications, high-density polyethylene is one of the more significant ones. Approximately 800,000 tons of this resin were produced in 1970, almost all was utilized by the packaging industry.

To produce 1 ton of high-density polyethylene, 72 gallons of refined crude oil are required, as well as 338 gallons of natural gas liquids. The energy required for production is estimated to be 38.6 million Btu's. A substantial portion of this production energy, approximately 37 million Btu's, is derived from fossil fuels.

In addition to these processing characteristics, it is important to note that 90 percent of all packaging is discarded within a year of purchase by the consumer. This means that 57 million tons of packaging enter the solid waste stream annually, including 13 million tons of bottles, 6 million tons of steel and aluminum cans, and 2 million tons of plastics. Perhaps more significantly, all the resources consumed and all the pollutants created are for the manufacture of service products with life spans of less than 12 months.

What Can Be Done

To ease some of these problems of resource utilization and pollution, three directions might be pursued. First, less packaging material could be consumed than is currently the practice. Second, more of the packaging that is produced could be reused for the same purpose. And third, much of the remaining packaging material could be recycled.

Decrease Consumption. The primary purpose of packaging is to protect and preserve the item being packaged. This function appears non-negotiable, and to decrease packaging consumption at the expense of product preservation would be difficult.

On the other hand, overpackaging a product to increase marketability seems to be a negotiable demand, particularly if the acquisition, manufac-

ture, or disposal of the excess material is environmentally damaging. The same may be said for packaging an item in what has come to be called a "convenience container." If the acquisition, manufacture, or disposal of the convenience container produces negative environmental impacts, and these impacts could be decreased by use of a different but functionally adequate container, a switch could be made without affecting the protection of the product that is to be consumed. The new environmental ethic suggests reversing current trends toward more overpackaging and convenience packaging.

Reuse Packaging. Another option for altering the current rates of resource depletion and pollution involves reusing packaging materials. This would require changing the current container system as well as altering consumer behavior patterns. This option is of great importance. We must orient ourselves toward not simply getting rid of pollution, but toward producing systems that do not pollute excessively. A reusable container is one such system.

It has been estimated, for example, that a container system of non-returnable beverage cans uses 51,830 Btu's per gallon of soft drinks, while a system of 12-ounce returnable glass containers uses only 17,820, a saving of approximately 34,000 Btu's per gallon. Reductions in material resources used and pollution generated would be equally significant under a system of reusable containers, even if the average reusable container makes only eight trips. In addition, a reusable container system averts the negative environmental effects of inadequately controlled solid waste disposal.

Recycle Packaging. For packaging that is functionally important and not potentially reusable, another sound environmental option is recycling. To continue to produce, consume, and then discard as waste would only worsen

existing conditions until the situation becomes severe enough to limit alternative actions.

The present patterns of man's consumption of nature's wealth do not reflect the balance found in nature's own life cycles. We produce items and then discard them without thought of their potential reuse. Only 10 percent of the packaging produced in the United States is returned for reuse or reprocessing into new products. The environmental damage is enormous, not only from attempts to effectively dispose of the discarded materials, but also from the packaging production processes themselves.

Substitution of waste materials for virgin materials in the production systems will decrease energy requirements and air and water effluents. If the amount of waste glass or cullet used in the production of glass containers is increased by 45 percent, for example, water consumption will decrease by 50 percent, mining wastes by 79 percent, and atmospheric emissions by an average of 14 percent. If the quantities of recycled material utilized are increased significantly, similar decreases in negative environmental impacts can be expected from all the major material systems from which packaging is made.

In this discussion of the three major options to be pursued in order to decrease environmental damage caused by packaging, the implementation costs have not been detailed. Certainly, any major changes in the existing production-consumption-discard cycle will cause socioeconomic dislocations. Where the environmental damages are significant, however, we should be willing to assume the economic and social costs. We simply cannot live indefinitely in a finite world as if it had no limits.

Summary

In summarizing, we must begin to consider actions that will reduce the negative environmental impacts produced by the present packaging systems. We are, for example, beginning to see limits to the availability of raw materials needed to make some packaging materials. Second, and equally important, is the rapid depletion of the energy sources required for the production of packaging.

In addition to the natural-resource issue, it is important to recognize the potential reduction in pollution that would result from reusing and recycling containers. A new system in which consumption is decreased, and materials reused and recycled would be in line with our national commitment to a new environmental ethic.

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